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Reliability of the National Income and Product Accounts
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November 16, 2001

I. Introduction and summary

The goal of the national income and product accounts (NIPA's) is to provide a comprehensive and reliable description of the condition of the domestic economy. The featured measures–gross domestic product (GDP) as well as its components, and gross domestic income (GDI) and its components–provide a snapshot of the economy and are useful to planning by both government and business.

The term "reliability" in this article's title refers to the magnitudes of revisions to the estimates of the featured measures; the revisions are the changes from an earlier vintage of estimates to a later vintage. The latest-available estimates–which are presumed to be the best estimates–are used as the standards for reliability in most of this article. Revisions do not necessarily reflect errors in the earlier estimates, nor does a lack of revision necessarily reflect the absence of errors. Note that the measure of reliability is not a measure of accuracy in the statistical sense. In statistical work, the term "accuracy" refers to the total measurement error, which in the NIPA's is never observed. Accordingly, it is not possible to exactly measure the accuracy of estimates. Box 1 describes the meaning of revisions and box 2 describes the various vintages of NIPA estimates. The boxes are located at the end of the text portion of this document.

This study finds–as did previous studies–that the estimates of GDP, real GDP, and GDI and their major components have been reliable.[1] As indicated below, and using the latest estimates as standards of reliability, since the early nineteen eighties current quarterly real and current-dollar GDP and GDI have had average revisions–without regard to sign–of somewhat more than one percentage point at an annual rate. In general, revisions to the major components have been somewhat larger, but have largely offset each other.

In addition, since the early nineteen eighties, the current quarterly estimates of real GDP have successfully indicated its direction of change 97 percent of the time. These estimates have also successfully indicated whether real GDP is accelerating or decelerating about three-fourths of the time.

The performance of real GDP estimates around cyclical peaks and troughs is often used

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1. This is the fourteenth of a series of BEA-supported studies of revisions to GDP and related measures. The first covered the period 1942-62 (Jaszi, 1965). Studies published prior to the 1991 comprehensive revision emphasized GNP and its components. Studies published thereafter have emphasized GDP and its components. Young (1993) discusses five of the earlier studies. A list of the studies is at the end of this article.

as an indicator of reliability. The cyclical peak was correctly captured in four of the last five recessions. The miss was for 1990-III; the current quarterly estimates showed a slowing in the second quarter and a further slowing–rather than a small decline–in the third quarter. The cyclical trough was correctly captured in three of the last five recessions. All of the misses were within one quarter of the latest estimates of the timing of cyclical peaks and troughs.

The remaining sections of this article describe various quantitative measures of revisions current-dollar and real GDP, in GDI, and in their major components. Section II presents statistics about quarterly estimates of GDP and its major components that emphasize measures of average revisions, and presents additional analyses of revisions to quarterly estimates of GDP and looks at revisions to seasonal factors. The section also examines revisions to successive vintages of quarterly estimates of GDP. Section III presents statistics about revisions to annual estimates of GDP and its major components and examines the revisions that arise at the time of comprehensive revisions. Section IV presents statistics about average revisions to quarterly estimates of GDI and its major components. Section V presents statistics about average revisions to annual estimates of GDI and its major components. Section VI contrasts revisions to GDI with the corresponding revisions to GDP. Section VII presents summary conclusions.

II Revisions to quarterly estimates of GDP and its major components

A. Mean and mean absolute revisions to quarterly estimates of GDP

The measures of reliability featured in this article are mean revision, mean absolute revision, and relative mean absolute revision, which are calculated as follows.[2]

Mean revision is the average of the revisions:

$$\mathbf{MR} = \frac{\sum (\mathbf{L} - \mathbf{E})}{\mathbf{n}}$$

where E is the percentage change in the earlier quarterly (or annual) estimate, L is the percentage

2. Previous NIPA revisions studies at BEA have featured bias, dispersion, and relative dispersion. Mean revision is the same as bias with the sign reversed. With mean revision, upward revision from the earlier to the later estimate are shown as positive; this will probably be more intuitive to most readers. Mean absolute revision and relative mean absolute revision yield the same values as dispersion and relative dispersion because of the taking of absolute values in the calculations.

change in the later estimate–typically the latest estimate–and n is the number of observations in the sample period over which the summation is calculated.

Because revisions can be positive or negative, it is useful to look at the mean revision without regard to sign. The mean absolute revision is the average of absolute values of the revisions:

$$\mathbf{MAR} = \frac{\sum |\mathbf{L} - \mathbf{E}|}{\mathbf{n}} .$$

Relative mean revision expresses the mean absolute revision as a percentage of the average of the absolute values of the later estimate:

$$\mathbf{RMAR} = \frac{\sum |\mathbf{L} - \mathbf{E}|/\mathbf{n}}{\sum |\mathbf{L}|/\mathbf{n}} .$$

This measure scales the mean absolute revision by the average absolute change in the latest estimates to account for differences in the magnitudes of change.

Table 1 shows mean absolute revisions and relative mean absolute revisions for current quarterly current-dollar and real GDP and its major components for 1983-2000. For GDP, there is a modest decrease from the advance to the preliminary estimates, and no further decrease for the final estimates.

The three vintages of the current-dollar estimates of GDP, however, have mean absolute revisions of slightly more than one percentage point, and the real estimates are about 0.1 percentage point larger. The relative mean absolute revisions for real GDP, however, are much larger than those for current-dollar GDP, 32 and 33 percent versus 16 and 17 percent. These larger relative mean absolute revisions reflect the larger mean absolute change for current-dollar GDP: For the 1983-2000 period, the mean absolute rate of change of current-dollar GDP is 6.4 percent, and that of real GDP, 3.2 percent.[3]

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3. A 1-percentage-point revision to the change in current-dollar GDP, with no revision to prices or weights, will result in a 1-percentage-point revision in real GDP. Thus, the effect on relative mean absolute revision will be larger for real GDP because its denominator–the mean absolute rate of change–will be smaller than the denominator for current-dollar GDP. (The average rate of change of real GDP for the 1983-2000 period is 3.5 percent, and the average rate of change of current-dollar GDP is 6.2 percent.) In addition, revisions to prices generally have only

The revision patterns for the components of current-dollar and real GDP are similar. From the advance to preliminary estimates, mean absolute revisions decrease for all 17 of the current-dollar components, and 14 of the real components. However only 6 of the current-dollar and 6 of the real components decrease from the preliminary to the final estimates. With the exceptions of personal consumption expenditures (PCE), the components' mean absolute revisions are considerably larger than the corresponding ones for GDP. The three components of PCE–durable goods, nondurable goods, and services–have mean absolute revisions larger than those for total PCE. Likewise the components of fixed investment have mean absolute revisions larger than those for total fixed investment. In contrast, the mean absolute revisions for State and local government expenditures are much smaller than those for total government expenditures.

Because the change in private inventories is frequently negative, it is not possible to calculate percent changes or percentage point revisions measures for them. However, the effects of revisions to changes in private inventories can be approximated by comparing the revisions measures for the three current quarterly estimates of gross private domestic investment (GPDI)–which includes change in private inventories–with those for fixed investment, which does not. The mean absolute revisions for GPDI are more than double those for fixed investment, indicating that revisions to estimates of inventories contribute significantly to revisions to estimates of GPDI.[4]

Table 2 shows mean absolute revisions for current-dollar and real GDP and their major components and sub-components for two periods, 1983-92 and 1993-2000. The presentation of two time periods separates the earlier period, which has now been fully benchmarked to input-output tables–including the 1992 table–from the later period, which will be revised when the NIPA's are benchmarked to future input-output tables. In addition, the later period incorporates a change in the treatment of purchases and sales of agricultural goods by the Commodity Credit Corporation (CCC) and an improvement in the Census Bureau's procedures for the processing of information about international trade in goods; these two changes, which were made in 1991 and 1985, respectively, substantially affected quarterly changes in business inventories, government expenditures, and imports of goods. Further, the later period includes only 3-plus years of real GDP estimates before a conversion to chain indexes from fixed-weight indexes occurred. The

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relatively small effects on the revisions to real measures in comparison to the effects of revisions to current-dollar estimates.

4. Previous revisions studies, however, have found that average absolute revisions to final sales (GDP less change in private inventories) were only slightly smaller than those for GDP. Thus, revisions to inventories tend to be offset by revisions to the other components of GDP.

conversion to chain calculations eliminated the sensitivity of percent changes in the real estimates to changes in base period for price indexes used in their estimation.

The effects of the CCC-related changes may be seen by comparing the mean absolute revisions of the estimates of GPDI and of fixed investment. The mean absolute revisions for GPDI are substantially smaller in 1993-2000, but those for fixed investment are only modestly smaller. Likewise the mean absolute revisions for government expenditures, and its components that include Federal nondefense purchases are substantially smaller in 1993-2000. (GDP is unaffected because the revisions were offsetting.)

The improvements in the processing of source data concerning the international trade in goods have resulted in substantial reductions in mean absolute revisions to the later period. In particular, the mean absolute revisions for imports in the later period are about one-third the size of those in the earlier period. The improvements had smaller, but still noticeable effects on imports.

Overall, the mean absolute revisions for current-dollar and real GDP and most of their components in the later period are generally smaller than their counterparts in the earlier period. However, because the later estimates have been subject to fewer vintages of revisions, this does not necessarily indicate that the revisions will ultimately be smaller than those of the earlier period.

Table 3 shows mean revisions to current-dollar and real GDP and their major components for the period 1983-2000. The mean revisions for GDP are small and positive, indicating a tendency toward upward revisions. The mean revisions for the preliminary and final estimates are about one-tenth percentage point smaller than those for the advance estimates. The mean revisions for PCE and its sub-components are also positive. With the exception of the current-dollar advance estimates, mean revisions for GPDI, and fixed investment are negative. With the exception of nonresidential structures, the mean revisions of most other investment sub-components are also negative. The mean revisions for exports are large and positive, whereas the final current dollar and all three vintages of real imports estimates are negative. Mean revisions for overall government expenditures are positive, as are those for most finer-level components. Mean revisions for current-dollar nondefense expenditures, however, are large and negative, whereas mean revisions for the corresponding real expenditures are large and positive.

B. Reliability of final estimates of real GDP near cyclical turning points

The behavior of the estimates around cyclical turning points provides another view of the reliability of the estimates. Table 4 shows the mean absolute revisions and mean revisions around the peaks and troughs for the last five recessions, beginning with the 1969-70 recession.

"Peak" identifies the last positive quarter before the onset of a recession, and "trough" identifies the last negative quarter before the beginning of a recovery. "Previous" identifies the quarters immediately preceding peak or trough quarters, and "next" identifies the quarters immediately following peak or trough quarters.

At cyclical peaks, the mean absolute revisions for both advance and final estimates of real GDP are somewhat smaller than the overall 1983-2000 mean absolute revisions shown in table 1, and well within the range of 1.4 to 2.4 percentage points found in earlier BEA revisions studies that covered the 1960's and 1970's. The mean revisions are slightly smaller than those for the period 1983-2000. However, with respect to peaks, the previous quarters have mean absolute revisions nearly double those for 1983-2000 and mean revisions that are much smaller but indicate overestimates of growth rates. The next quarters–the first "down" quarters–have modestly higher mean absolute revisions, but have mean revisions that are somewhat smaller than those for the 1983-2000 period. The relative sizes of the averages of revisions must be interpreted cautiously because there are only five observations, and averages–especially mean revisions–tend to be quite sensitive to the period examined.

At cyclical troughs, the revisions are noticeably larger than at peaks. The mean absolute revisions for both advance and final estimates are roughly double the 1983-2000 values. Similarly large mean absolute revisions are found for both the previous and the next quarters–the first "up" quarters. Although the mean revisions are small at the troughs , they are up to 2 ½ percentage points for both the previous and the next quarters. Thus, the upward revisions to the advance and final estimates for these quarters indicates that there is a tendency to overstate declines immediately prior to troughs and understate growth in the first quarters of recoveries.

C. Additional analysis of revisions to quarterly GDP estimates, 1983-2000

Table 5 shows the relationship between the final current quarterly estimates of real GDP and its long-term trend rate of growth, which is defined to be an annual rate of growth between 1.5 percent and 4.5 percent. The rows of the table describe whether the final quarterly estimates were above, near, or below trend. The columns describe whether the latest estimates are above, near, or below trend. Each entry in each row indicates what percent of final estimates in each category are in each category in the latest estimates. For example, the upper left-hand entry indicates that 74 percent of final estimates that were above trend remain above trend in the latest estimates. The rows each sum to 100 percent, but the columns do not.

Generally, in addition to most above-trend final estimates remaining above trend in the latest estimates, none of the above-trend final estimates are below trend in the latest estimates. Similarly, most of the near-trend final estimates are still near trend in the latest estimates, although one-fourth are above trend, and somewhat less than one-tenth are below trend. More

than half of below-trend final estimates are near trend in the latest estimates, and the remainder remain below trend. Note that none of the above or below trend final estimates are revised to below or above trend.

Thus, the final current quarterly estimates of GDP are reliable in the sense that revisions do not generally change the relationship between that estimate of GDP growth and the trend growth rate. However, note that revisions to real GDP tend to be upward when moving from the final to the latest estimates; this is consistent with the upward average revision shown in table 3. Qualitative results for the advance and preliminary current quarterly estimates of real GDP are similar, and are not shown.

Examining revisions by their size provides another picture of the estimates of GDP and its major components. Table 6 shows revisions to current-dollar GDP and its major components from final to latest estimates for 1983-2000, grouped by size class of revision. This table supplements the mean average revision and mean revision statistics shown in tables 1 and 3. Rows of the table sum to 100 percent.

Revisions to GDP are generally small; 84 percent are no greater than 2 percentage points, and only one percent was greater than 3 percentage points. Note that the average GDP growth rate for the period of 6.37 percent.

Revisions to the major components are somewhat larger. Although 88 percent of personal consumption expenditures revisions are less than 2 percentage points, 5 percent are between 3 and 5 percentage points. Revisions to GPDI are generally much larger; just 16 percent are less than two percentage points, and 61 percent are been more than 5 percentage points. Although typically large revisions to inventories are behind the large revisions, only 51 percent of revisions to fixed investment (which excludes inventories) are less than 2 percentage points, and 16 percent are more than 5 percentage points.

Revisions to exports, imports, and Federal government expenditures are also often large; revisions larger than 5 percentage points occurring 31, 25, and 37 percent of the time, respectively. The revisions to State and local government expenditures are typically somewhat less large; 51 percent are less than two percentage points, and none are more than 5 percentage points.

In addition to the mean absolute revisions and mean revisions statistics featured in this article, measures of dispersion can provide additional information about the nature of revisions. Although such measures can be calculated for both mean revisions and mean absolute revisions, the following analysis focuses on mean absolute revisions. The standard deviation of the mean absolute revision is defined as:

$$\text{Standard Deviation} = \sqrt{\frac{\sum (|L - E| - MAR)^2}{n}} \quad .$$

The distribution of the mean absolute revisions can also be characterized by the mean deviation. More specifically, the mean absolute deviation is the average absolute value of the absolute value of revisions less the mean absolute revision:

$$\mathbf{MAD} = \frac{\sum ||\mathbf{L} - \mathbf{E}| - \mathbf{MAR}|}{\mathbf{n}}$$

Also, the coefficient of variation of the absolute revisions is the ratio of the standard deviation to the mean absolute revision:

$$\mathbf{CV} = \mathbf{SD} / \mathbf{MAR} \quad .$$

The coefficient of variation for the mean revision can be obtained by substituting MR for MAR in the above expression.

Table 7 shows the above measures for the final estimates of current-dollar and real GDP and their components for 1983-2000. Standard deviations for current-dollar and real GDP are somewhat smaller than the mean absolute revisions except imports and Federal expenditures and Federal nondefense expenditures. (Given the standard deviations, the mean revisions for current-dollar and real GDP are not statistically different from zero at the .95 percent level.) Likewise the standard deviations for most components are somewhat smaller than the corresponding mean absolute revisions; exceptions are for imports and Federal and Federal nondefense expenditures. As is the case for mean absolute revisions, all the components' standard deviations are larger than those for GDP. The standard deviations for PCE are the smallest among those of the components, and the standard deviations for Federal nondefense expenditures are the largest.

Mean absolute deviations for current-dollar and real GDP and their components are all somewhat smaller than the corresponding standard deviations, and the same patterns observed for standard deviations are observed. Mean absolute deviations for imports and Federal expenditures and Federal nondefense expenditures are smaller than the corresponding mean absolute revisions.

Coefficients of variation are nearly all less than 1.00, with the exceptions of imports,

Federal expenditures, Federal nondefense expenditures, and real government expenditures. The same patterns observed for the other summary measures are again observed for GDP and most components: Exceptions are the various investment measures, which are coefficients roughly the same size as those for PCE and its components; also the coefficients of variation for exports are smaller than those for PCE, and the coefficient of variation for current-dollar exports is slightly smaller than that for GDP. Note that because the mean absolute deviations are smaller than the standard deviations, their use in computing the coefficient of variations would result in smaller values and in the case of imports it would move from a value of greater than 1.00 to a value less than 1.00.

The upshot is that the distribution of the mean absolute revision for GDP is relatively tight as it is for some of the underlying components, such as PCE. The illustrated pattern is qualitatively the same for the bilateral comparison of the other vintages of estimates. Accordingly, inferences drawn from the pattern of the movement of mean absolute revisions across vintages is informative.

D. Decompositions of the average revisions statistics

Additional information about the nature and distribution of revisions may be gained by examining the revisions statistics discussed in section II B by quarter. Such a decomposition reveals new patterns of change and illustrates the role of season of estimates.

BEA estimation methods in the absence of later source data make it possible that average revisions for each of the quarters of years--examined separately–may differ. That is, that average revisions for the estimates of the first quarters may be different from the average revisions for each of the other quarters, as well as the average revisions for all quarters that have been presented up until now in this article.

Table 8 shows mean absolute revisions and mean revisions for final estimates of current-dollar and real GDP and their components for 1983-2000, by quarter. That is, mean absolute revisions for all first quarters, all second quarters, all third quarters, all fourth quarters, as well as for all quarters; these latter are the same summary measures as those presented previously in tables 1 and 3.

The upper panel presents current-dollar summary statistics and the lower panel presents real summary statistics. The first five columns show mean absolute revisions. The mean absolute revisions for current-dollar GDP range from a low of 0.80 percentage points for second quarters to a high of 1.45 percentage points for fourth quarters; this compares with a mean average revision of 1.05 percentage points for all quarters. Thus, the mean absolute revisions for the various quarters range from 24 percent below to 38 percent above that for all quarters.

The differences in mean revisions among quarters are even more striking. The mean revisions for GDP range from a low of -0.19 percentage points for third quarters to a high of 1.14 percentage points for fourth quarters; this compares with a mean revision of 0.34 percentage points for all quarters.

The quarter-by-quarter patterns of mean absolute revisions for GDP components differ considerably. Some components show little change from quarter to quarter. For example, exports' mean absolute revisions for individual quarters range from 2 percent below to 3 percent above that for all quarters. Other components show considerable change from quarter to quarter. For example, equipment and software investment's mean absolute revisions for individual quarters range from 10 percent below to 27 percent above that for all quarters. Also residential investment's mean absolute revisions range from 62 percent below to 25 percent above that for all quarters. The quarterly variation in mean absolute revisions for change in private inventories cannot be observed directly, but their impact is suggested by the larger range of gross private domestic investment–from 24 percent below to 43 percent above the average for all quarters–compared to the range for fixed investment–from 20 percent below to 15 percent above the average for all quarters.

The patterns of mean revisions for components also differ considerably. Some components have mean revisions that are always of the same sign. For example the mean revisions for PCE vary from 0.15 percentage points to 0.68 percentage points compared to a mean revision of 0.42 percentage points for all quarters. Others, as with GDP, have mean revisions that change sign from quarter to quarter. For example, the mean revisions for exports are -0.41 percentage points for first quarters, 3.75 percentage points for second quarters, -1.90 percentage points for third quarters, and 1.38 percentage points for fourth quarters; the mean revision for all quarters is 0.70 percentage points.

The average revisions for real GDP and its components are generally similar to those for current-dollar GDP. The mean absolute revisions for real GDP range from 1.05 percentage points for second quarters to 1.46 percentage points for fourth quarters; this compares with a mean average revision of 1.23 percentage points for all quarters. Thus, the mean absolute revisions for the various quarters range from 15 percent below to 16 percent above the mean absolute revision for all quarters.

The quarter-by-quarter patterns of real GDP components' mean absolute revisions for the individual quarters again differ considerably, but are not always in lock step with the mean absolute revisions for current-dollar estimates. For example, real exports' mean absolute revisions vary from 31 percent below to 18 percent above that for all quarters, a much larger variation than observed for current-dollar exports. Conversely, real equipment and software investment's mean absolute revisions vary from 16 percent below to 14 percent above that for all

quarters, a smaller variation than observed for current-dollar equipment and software investment.

The pattern of mean revisions for real GDP and its major components are roughly similar to those observed for their current-dollar counterparts. Mean revisions for real GDP range from -0.18 percentage points for the third quarters to 0.94 percentage points for fourth quarters; these compare with a mean revision for all quarters of 0.38 percentage points. Again, some components have mean revisions that have the same signs in all quarters, whereas others change sign from quarter to quarter.

The quarter-by-quarter decompositions of mean absolute revisions and mean revisions for both current-dollar and real GDP and their components thus typically vary considerably from overall averages and fluctuate considerably from one quarter to the next. This finding warrants further research that is beyond the scope of the present study. Furthermore, it suggests a closer examination of seasonal adjustment of GDP and its components.

BEA seasonally adjusts some GDP components, but most source data are provided on a seasonally adjusted basis. Because of changing seasonal patterns, the seasonal factors used to adjust series are recompute annually. Box 3 discusses seasonal adjustments and their revisions, and describes how seasonal factors were estimated in this analysis.

Previous BEA studies have found that revisions to seasonal factors for GDP are substantial when compared to revisions to seasonally adjusted GDP.[5] As indicated in Young (1996), "the average absolute revision in the quarterly changes in the seasonal factors in the period 1983 to 1988 ... is about one half the size of the total revision (seasonally adjusted) from the current estimates to the latest available estimate of GDP." Thus, BEA has had the view that revisions to seasonal factors are an important factor in revisions to seasonally adjusted GDP estimates.

Seasonally unadjusted quarterly estimates of current-dollar GDP and its components are published about two months after annual or comprehensive revisions. Typically, the annual-revision estimates show quarterly estimates for the preceding four years, but only the later three years are revised. This means the seasonally-unadjusted estimates correspond to first through third annual revision estimates. The estimates do not give a full picture of the effects of the revisions to seasonal factors for two reasons. First, some source data are not available on a seasonally-unadjusted basis, or the seasonally-unadjusted data is constructed at a different level

5. In addition, BEA found that the downward revision to the seasonal factor for change in private inventories in 1990-III revised them down more than half the downward revision in GDP; this was the cyclical peak quarter in the current quarterly estimates, but has been revised to be the first "down" quarter.

of detail than the seasonally-adjusted estimates. Second, some seasonal factors change between the current quarterly estimates and the first annual revision estimates; these revisions are not captured. Nevertheless, it is possible to study the effects of revisions to seasonal factors between the first and third annual revision estimates.

Table 9 presents the revisions to quarterly current-dollar GDP and its major components resulting from revisions due to causes other than seasonal factors and revisions due to seasonal factors, from the first to third annual revision estimates for 1987-97. The three columns show mean absolute revisions from the first to third annual estimates for the seasonally adjusted estimates, the seasonally unadjusted estimates, and for the unrevised seasonally unadjusted estimates times the revised seasonal factors–that is, the revisions due to seasonal factors alone. The first row of table 9 shows that the mean absolute revision for seasonally adjusted GDP was 0.67 percentage points, that for seasonally unadjusted GDP was 1.73 percentage points, and that for the GDP seasonal factor was 1.00 percentage points. Overall, the mean absolute revisions for the seasonally unadjusted estimates are much larger than those for the seasonally adjusted estimates for GDP and all its major components except imports. The mean absolute revisions due to seasonal factors are also larger than the corresponding revisions for seasonally-adjusted GDP and its major components, except imports.[6] Thus, mean absolute revisions for both seasonally unadjusted estimates and revisions due to seasonal factors are both larger than the seasonally adjusted estimates. In the most extreme case, Government expenditures, the two mean absolute revisions are 4.51 and 2.82 percentage points, which are both larger than the 1.68 percentage point mean absolute revision to the seasonally adjusted estimates.

These findings indicate that the revisions due to seasonal factors tend to offset revisions to seasonally unadjusted estimates. Accordingly, BEA's earlier view may have overemphasized the importance of revisions to seasonal factors because it did not consider offsets.[7] In a sense, this finding is not surprising because the purpose of seasonal adjustment is to smooth out seasonal-frequency jumps in a series. For example, an upward revision in an estimate leads to a downward revision in the corresponding seasonal factor (however some jumps in estimates are determined to be outliers, and are not used in seasonal adjustment calculations). In sum, revisions to seasonal factors are not a principal source of volatility in the estimates. Again, a more detailed analysis of this finding is warranted.

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6. Revisions to inventory seasonal factors are not directly measurable, but have large effects. The mean absolute revisions for gross private domestic investment are much larger than those for fixed investment in all three columns. However, the mean absolute revision in final sales due to revisions to seasonal factors is just somewhat larger than that for GDP; this suggests that the revisions to inventory seasonal factors tend to be offset by revisions to the seasonal factors for other components of final sales.

7. The difference in magnitude between table 9 and Young's result reflects different time periods and different revision vintages–first annual to third annual in this study, versus current quarterly to latest.

E. Successive vintages of GDP revisions

This section analyzes whether a revision in estimates of GDP from one vintage to the next is likely to be followed by similar revisions to succeeding vintages for the 1983-98 period. Data that would allow a complete evaluation of the 1999-2000 estimates are not yet available.

Table 10 looks at the relationship of successive vintages of revisions by showing the correlations of each vintage of revisions with each successive vintage of revisions. For example, the upper left-hand entry indicates that there is a correlation coefficient of -0.11 for the advance to preliminary revision with the preliminary to final revision. Generally, the correlations are quite small, but generally positive. The largest correlation, 0.55 for the second to third annual revision with the third annual to latest revision, is nearly twice the size of the next largest correlation.

These correlations reflect a number of factors. One is that there is nearly an equal chance that a revision from one vintage to the next will be either up or down. Looking at estimates of current-dollar GDP for 1983-98, the share of upward revisions is only slightly more than half for most successive pairs of revisions, such as the advance to preliminary or the third annual to final. Overall, the share of upward revisions for all the successive vintages is 54 percent.

Additionally, although an upward (or downward) revision from the advance to the preliminary estimate of current-dollar GDP is modestly more likely to be followed by another upward (or downward) revision for the final estimate; for other pairs of vintages of estimates, the reverse is true. Thus, beginning with the preliminary estimates and going through the third annual estimates, only 39 percent of upward (or downward) revisions are followed by another upward (or downward) revision.

Another factor is the sizes of mean absolute revisions for current-dollar GDP from one vintage of estimates to the next. The mean absolute revision from the advance to the preliminary estimates is 0.55 percentage point; from the preliminary to final estimates it is 0.28 percentage point. Thereafter, the mean absolute revisions from one vintage to the succeeding vintage are each roughly three-quarters of a percentage point.

Thus, a revision of any given vintage contains very little information about any successive vintage of revision. That is, revisions do not have momentum. Although not shown here, there is no quarter in the 1983-1998 period when all five vintages of revisions to current-dollar GDP are in the same direction, either positive or negative.

III. Annual estimates of GDP and its major components

A. Mean and mean absolute revisions

Table 11 shows mean absolute revisions and mean revisions for annual-frequency current-dollar and real GDP and their major components for 1983-98. The successive vintages of annual estimates incorporate the increasing amounts of source data that become available following the end of each year.[8] Again, data that would allow a complete evaluation of the 1999-2000 estimates are not yet available.

The estimates of annual current-dollar and real GDP and their major components have much smaller mean revisions than those for the current quarterly estimates of quarterly GDP shown in table 1. The sizes of the mean absolute revisions tend to decrease as the successive annual revision estimates are made. For GDP, the largest decreases occur between the sum of finals and first annual estimates; in part, this reflects the fact that annual estimates are unaffected by revisions to seasonal adjustments. Among the annual-revision estimates, the largest decreases occur between the second and third annual estimates. As found with the quarterly estimates, the mean absolute revisions for real GDP and its major components are somewhat larger than those for current-dollar GDP and its major components. Also like the quarterly-frequency estimates, the mean absolute revisions for current-dollar and real GDP are generally smaller than those of their major components. Among the components, PCE has the smallest mean absolute revisions and nonresidential fixed investment and Federal government expenditures have the largest.

The mean revisions for current-dollar and real GDP and their major components have values that are roughly similar to those for the current quarterly estimates of GDP. Again, most mean revisions for investment are negative, as are those for real imports. Most other mean revisions are positive, as are the revisions for the second and third annual estimates of nonresidential fixed investment.

B. Comprehensive revisions to current-dollar GDP

Comprehensive revisions tocorporate both statistical and definitional revisions.[9] Definitional revisions are made to adapt the NIPA's to a changing economy and have little to do with reliability. In addition, definitional revisions have generally increased the levels of both

8. Annual revisions were not made in the years of comprehensive revisions, 1985, 1991, 1996, and 1999. Benchmark revision estimates–which incorporate the information contained in annual revision estimates were substituted for the "missing" annual estimates.

9. Statistical revisions generally reflect incorporation of better data including new input-output tables, but it is sometimes difficult to separate revisions that are due to better data from those that are due to methodological improvements. For example, the 1996 comprehensive revision incorporated a better methodology for calculating depreciation, but also incorporated new and revised source data on investment.

current-dollar and real GDP. For example, the recognition of software as investment in the 1999 comprehensive revision substantially increased the levels of GDP. Chart 1 shows the effects of definitional and statistical revisions to the 1999 comprehensive revision on levels of current-dollar GDP in 1987-98. The definitional revisions increased the levels by large and increasing amounts throughout the period. In contrast, the statistical revisions were small and both positive and negative for the years until 1994; thereafter they added to the levels by amounts that increased rapidly.

Although definitional revisions increased the levels of current-dollar GDP in both the 1996 and the 1999 comprehensive revisions, in the 1996 revision, the upward revisions did not increase as rapidly as GDP for the period 1982-95. As a result, the definitional revisions had the effect of lowering the average growth rate. Statistical revisions increased the average growth rate, and very more than slightly offset the effects of the definitional revisions, resulting in a total revision that was positive, but less than .005 percentage points (table12).

In the 1999 comprehensive revision, both definitional and statistical revisions increased the average growth rate of GDP in 1982-95, but most of the increase was due to definitional revisions. In 1995-98 , the rapidly increasing statistical revisions had even larger effects on GDP growth than the definitional revisions; together they produced a 0.38 percentage point increase in the average growth rate.

Comprehensive revisions thus change average growth rates of GDP, generally increasing them in the long run. Over the 1978-I to 1991-III period, the average growth rate of GDP was revised up 0.16 percent from the 1991 comprehensive estimates to the 1996 comprehensive estimates; over the 1978-I to 1995-III period, the average growth rate was revised up 0.08 percent from the 1996 comprehensive estimates to the 1999 comprehensive estimates; and over the 1978-I to 1995-III period, the average growth rate was revised up 0.15 percent from the estimates in place prior to the 1999 comprehensive to the revised estimates.

Comprehensive revisions also result in substantial mean absolute revisions from the previous comprehensive revision estimates. Comparing the same three pairs of revisions, over the same time periods, the mean absolute revisions for quarterly estimates rates of change of current-dollar GDP were 0.53, 0.54, and 0.55 percentage points, respectively. These are not greatly smaller than the 0.77 percentage point mean absolute revision from the third annual estimates to the latest estimates for 1983-95.

IV. Revisions of estimates of GDI and its major components

This analysis of the income-side revisions is somewhat less detailed than that for current-dollar GDP. In particular, no detail about the distribution, by size class, for GDI is included, and no analysis is provided for successive vintages of revisions. In addition, BEA does not publish

or estimate seasonally-unadjusted estimates of GDI.

A. Mean and mean absolute revisions to quarterly estimates of GDI

Table 13 shows mean absolute revisions and mean revisions for current quarterly estimates of GDI, national income, and its major components for 1983-2000. The mean absolute revisions for GDI are somewhat larger than those for current-dollar GDP, and the mean absolute revisions for national income are even larger; the latter finding reflects substantial mean absolute revisions for the components that are added and subtracted from GDI to obtain national income–they are not fully offsetting.[10]

Among the major components of national income, only compensation of employees has mean absolute revisions similar in magnitude to those for most major components of GDP; the other components have much larger mean absolute revisions. These larger values reflect the very limited availability of current quarterly source data for all components of GDI other than compensation of employees and corporate profits. For the annual-revision estimates of the components, the second annual estimates incorporate the ultimately revised estimates. The large mean absolute revisions to proprietors' income reflect typically large revisions to estimates of farm proprietors' income; nonfarm proprietors' income has mean absolute revisions only about half as large as all proprietors' income. As with the product-side estimates, there is little tendency for reductions in mean absolute revisions when progressing from advance to preliminary to final estimates.

Mean revisions for GDI, national income, and major components are similar in size to those of current-dollar GDP and its major components; in fact, the mean revisions for GDI and national income are smaller than those of GDP. Thus, the larger mean absolute revisions do not translate into larger mean revisions.

B. Additional analysis of revisions to quarterly GDI estimates, 1983-2000

Table 14 shows mean absolute revisions and mean revisions for final estimates of GDI, national income, and its components for 1983-2000, disaggregated by quarter. As with the product side measures (shown in table 8), there are substantial differences in the mean absolute revisions for individual quarters; for GDI they range from 1.00 percentage points for fourth quarters to a high of 1.59 percentage points for first quarters, compared to an average of 1.20

10. Some of these components were greatly affected by the incorporation of a new depreciation pattern into consumption of fixed capital as well as a new treatment of government investment that were introduced in the 1996 comprehensive revision. The new depreciation patterns yielded revisions both to consumption of fixed capital and to the capital consumption adjustment for the three types of business income, and the new treatment of government investment resulted in the addition of consumption of capital for government.

percentage points for all quarters. This means that the mean absolute revisions for the various quarters range from 17 percent below to 33 percent above that for all quarters. The differences in mean revisions are also quite large. The mean revisions for GDI range from a low of 0.06 percentage points for third quarters to a high of 0.75 percentage points for fourth quarters, compared to an average of 0.25 percentage points for all quarters.

The quarter-by-quarter patterns of mean absolute revisions for national income and its various components all exhibit considerable fluctuation. Likewise their quarter-to-quarter patterns of mean revisions also exhibit considerable fluctuation. The mean revisions for national income, compensation of employees, and proprietors' income have both positive and negative sign, depending on the quarter.

V. Annual estimates of GDI and its major components

Table 15 shows mean absolute revisions and mean revisions for annual-frequency estimates of GDI, national income, and its major components for 1983-98. As with the quarterly-frequency estimates, mean absolute revisions for GDI and are somewhat larger than those for current-dollar GDP, and the mean absolute revisions for national income are somewhat larger than those for GDI. Also, as with the quarterly-frequency estimates, only compensation of employees has mean absolute revisions similar in magnitude to those of major components of GDP. As was seen for the successive annual revision estimates of the product side, the estimates of GDI, national income, and its components have substantial reductions in size moving from the final estimates to the first annual estimates, and further reductions moving to the second annual estimates. Moving to the third annual revisions, however, the mean absolute revisions increase slightly for GDI, national income, and some of its components.

Mean revisions for GDI, national income, and its components are similar in size to those of the corresponding vintages of estimates for current-dollar GDP, and its major components. For GDI and national income, the largest reductions occur between the "sum of finals" and first annual estimates.

Mean absolute deviations for GDI, national income, and its major components are smaller than the corresponding standard deviations. These findings are similar to those for GDP.

VI. GDI versus GDP

Some analysts have suggested that GDI contains information about the current state of the overall economy that is not fully conveyed by GDP alone. Some previous internal studies at BEA, however, failed to find that incorporating information about the final estimates of the growth rate of GDI into estimates of current-dollar GDP yielded a reduction in mean absolute

revisions for GDP from final to latest estimates. Likewise, only a weak indications was found that when final estimates of GDI grow more rapidly than those of GDP, the revisions to GDP tend to be up, and conversely, but the relationship was not statistically significant at even the 0.2 level.

There is a close relationship between final estimates of GDP and GDI, a and their correlation is 0.97 (chart 2). Similarly, the correlation of revisions to GDP and GDI from final to latest estimates is 0.48.

However, some analysts have also suggested that GDI estimates might be used to provide a more accurate picture of the economy near and during peaks and troughs. A comparison of GDP and GDI estimates in the last three business cycles, however, fails to indicate that GDI contained information that would have improved then-contemporary understanding of the economy.[11] As indicated in chart 3, GDP and GDI maintained their close relationship around and during the turning points of each of the three cycles. In terms of revisions, GDP estimates were closer to the latest estimates for all 3 peaks, but for only 1 of the troughs. In terms of the following quarters–the first "down" and first "up" quarters for real GDP, GDP estimates were closer than GDI 2 times after peaks and also 2 times after troughs. Thus there is only limited indication that examinations of GDI would provide additional information about the timing of business cycle turning points.

Nevertheless, further research may yet find a way to use information from estimates of GDI to reduce revisions to GDP estimates and provide improved contemporaneous understanding of the direction of the economy in and around business cycles.

VII. Conclusions

The principal results of this review of revisions are consistent with those of previous BEA studies of revisions. Estimates of current-dollar and real GDP, and GDI are generally reliable; the mean absolute revisions for the respective quarterly estimates are somewhat more than one percentage point, and those of the annual estimates somewhat less than one percentage point. The mean revisions for these measures are positive, primarily reflecting the impacts of comprehensive revisions that have increased the scope of economic activity in order to adapt the NIPA's to a changing economy. This study also found that the quarterly estimates were generally accurate in indicating whether the economy was growing at rates above, near, or below the long-term trend, but there is a modest tendency for upward revisions to the latest estimates.

This study is the first, however, to find that there is a modest decline in mean absolute

11. GDI was not estimated in the current quarterly estimates of the 1969-70 and 1973-75 recessions.

revisions for the current-dollar and real GDP, GDI, and most of their major components from the advance to the preliminary estimates. This is particularly true for the 1993-2000 period. There are also substantial reductions in the mean average revisions for annual estimates from those at the end of the first quarter following a year and those after the first annual revisions. There are also noticeable reductions in average revisions between the first and second, and second and third annual revision estimates.

This study also finds some aspects of revisions that were not described in recent studies; the findings resulted from both augmenting previous analyses and new types of analyses. The aspects include the following.

- The quarterly estimates of real GDP around cyclical turning points tend to overstate the declines in the first quarters following peaks and understate recoveries in quarters at and following troughs.

- Decomposing the reliability measures of current-dollar and real GDP, GDI, and their major components into the four quarters of the year indicates substantial differences among quarters for both mean absolute revisions and mean revisions.

- Decomposing current-dollar GDP and its major components into revisions due to revisions to seasonal adjustments and revisions due to other causes indicates that seasonal adjustment revisions are larger than the revisions to seasonally adjusted estimates, but revisions due to other causes are even larger; thus the two sources of revisions tend to offset one another.

- Decomposing revisions to current-dollar GDP and its major components by size class indicates that the large majority of revisions to GDP estimates are less than two percentage points, but most of its major components have many more large revisions.

- Correlations of successive vintages of revisions to current-dollar GDP are generally very small. This, combined with other ways of looking at successive revisions todicate that successive revisions do not have momentum.

- Although the 1996 comprehensive revision of the NIPA's raised the level of current-dollar GDP, it did little to the trend rate of growth as the effects of statistical and definitional revisions largely offset one another. In contrast, the 1999 comprehensive revision increased both the level of GDP and its growth rate–especially in the 1995-1998 period–as statistical and definitional revisions supplemented each other.

The findings of substantial differences in revisions by quarter and of the offsets of the effects of revisions to seasonal factors and revisions due to other causes both call for further

analysis.

Box 1: The meaning of revisions

Total measurement error arises from errors in the source data and in the estimating procedures that utilize the source data. The latest-available estimates are presumed to be the best estimates because it is believed that later source data are more accurate, and estimating procedures tend to improve over time.

Revisions, however, occur for several reasons. First, replacement of early source data with later, better data; this primarily occurs in the three years following the earliest quarterly estimates, and when comprehensive revision estimates are made based on input-output tables for years in which economic censuses are taken. Second, replacement of judgement with source data; this is particularly important in the successive vintages of current quarterly estimates of inventories, imports, and exports (particularly from advance to preliminary vintages). Third, changes in definitions and estimating procedures. Definitional changes are primarily made to adapt the NIPA's to a changing economy; an example was the recognition of computer software as investment in the most recent comprehensive revision. Changes in estimating procedures are generally made to respond to improvements in understanding of how to make estimates, or to respond to newly available source data. An example was the adoption of chain indexes in 1996; these made growth rates of real GDP and its components invariant to the choice of base period. Fourth, changes in seasonal adjustment factors. Because many seasonal adjustments are centered weighted averages, the final seasonal factors for a given year depend on future-year values that are not known at the time of the early vintages of quarterly estimates. Finally, corrections of errors in source data or computations. These latter are unusual, and typically have been documented in materials describing the estimates at the time the corrections were made.

Revisions may affect components, but not GDP or GDI. For example, a change in the allocation of autos sold between consumers and business will affect PCE and gross private domestic investment, but does not affect GDP.

Small revisions do not necessarily indicate good reliability. For example, some source data may present substantial measurement challenges, but are not revised. This leads to low average revisions for the expenditures estimates despite the challenges. Large revisions do not necessarily indicate poor reliability. For example, the recognition of computer software as investment increased the average growth rate of real GDP by roughly two-tenths of a percentage point over the 1987-98 period. Also, definitional changes may result in large revisions to

components of GDP that are offsetting and thus do not affect GDP. For example, the movement of Commodity Credit Corporation purchases–which are highly volatile–from the government sector to the business sector in the 1996 comprehensive revision resulted in large, but offsetting revisions to the two sectors without affecting either current-dollar or real GDP.

Further, the effect on revisions measures of changes in source data, definitions, and estimating methodology depends on the vintage of estimate in which the change is made. As explained in an earlier BEA study (Young, 1996, p. 436):

> (A)n improvement in the current estimates results in a permanent decrease in revision size, while an improvement in the latest available estimates results in a permanent increase in revision size. Improvement in both the current and latest available estimates results in little change. Improvement that is introduced retrospectively into the latest available estimates, as is often the case, results in an increase in revision size for a period of years until the improvement is also reflected in the current estimates. Thus one cannot assume a close correspondence between changes in the size of revisions and changes in accuracy.

Box 2: Vintages of revisions and timing

There are two frequencies of NIPA estimates, quarterly and annual. Three current quarterly estimates are made for each quarter and are labeled–in sequence–advance, preliminary, and final estimates. Each is released near the ends of the three months following the end of each quarter. In addition, three annual revision estimates are normally made for each quarter; these are released near the end of July in each of the first three years after a given quarter occurred. These are labeled the first, second, and third annual revision estimates. Exceptions occur in the years when comprehensive revisions are planed; in these years the annual revisions estimates are not made. Following the third annual revision estimates, new estimates for each quarter are generally not made until a comprehensive revision occurs; these revisions cover all the quarters for which estimates are published. Comprehensive revisions occur about every five years, following the publication of quinquenial input-output tables. In this article, the comprehensive revisions are labeled by the year that the completed version was released. For example, in this article the latest comprehensive revision is referred to as the “1999" benchmark; the preliminary and incomplete version was published in November, 1999, and the final and complete version in March 2000.

Likewise, there are a number of vintages of annual-frequency estimates. The vintage corresponding to the final current quarterly estimates of the previous year is released in late March of the following year, and usually contains a revised estimate of the first quarter of the

previous year that is made during an annual revision made during the year, This vintage of annual-frequency estimates is labeled "sum of finals" in this article. There are also three successive annual revisions to the annual-frequency estimates, labeled the first, second, and third annual revision estimates. Finally, the comprehensive revision labels are the same as those for the quarterly-frequency estimates.

Box 3: Seasonal adjustments and their revisions, and the calculation of seasonal factors

Much economic source data that are available at sub-annual frequencies (typically monthly or quarterly) contain within-year patterns that repeat, approximately, each year. For example, many stores make a large portion of their sales during the Christmas season. In order to determine what is new or distinctive about economic activity in a particular month or quarter, it is necessary to remove the effects of these recurring patterns by making seasonal adjustments.

Seasonal patterns change gradually over time. Thus, rather complex methods have been developed to deal with these and other complicating factors. At the present time, the most widely used seasonal adjustment method is the X-12 ARIMA method developed at the U.S. Census Bureau.[12] This method uses a statistical analysis to calculate how the seasonal adjustment pattern of a series has changed recently and how it might be expected to change further over the next year.

GDP estimates are based on a data that BEA receives from a large number of different sources, primarily other government agencies and from trade associations. Most of these data have already been adjusted for seasonal variation. Source data that are provided to BEA that have not been checked for seasonal patterns are tested for seasonality and adjusted using the X-12 ARIMA method if seasonality is found. Because of changing seasonal patterns, most the seasonal factors used to adjust series are recomputed annually. Data for an additional year improve the reliability of seasonal factors calculated for the most recent preceding years. The revised seasonal factors for the past three years are incorporated in the annual NIPA revisions. Revisions to seasonal factors for earlier years are incorporated in the comprehensive NIPA revisions that occur about every five years. For a few series, for which seasonal patterns change rapidly, new seasonal factors are calculated each quarter, a process called concurrent seasonal adjustment. The new seasonal factor is applied only to the current quarter; preceding quarters are not revised until the annual revision. NIPA series for which concurrent seasonal adjustment is used include change in private inventories and, to a lesser extent, private equipment and

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[12] Some source data are seasonally adjusted using similar programs, such as X-11 and X-11 ARIMA. The programs are all designed to take into account special factors that affect seasonal patterns, such as the number of business days in a period, or the date of Easter.

software.

Seasonal factors are not published by BEA, but may be calculated as

$$sf(t)^{1st} = X_{sa}(t)^{1st} / X_{nsa}(t)^{1st}$$

where:

sf(t) is the seasonal factor for GDP or a component in period t
X(t) is the estimate of GDP or a component in period t
1^{st} refers to the first annual revision estimate of X(t)
sa indicates seasonally-adjusted estimates
nsa indicates seasonally-unadjusted estimates

Revised seasonal factors are calculated as

$$sf(t)^{3rd} = X_{sa}(t)^{3rd} / X_{nsa}(t)^{3rd}$$

where 3^{rd} refers to the third annual revision estimate of X(t)

Estimates of measures with revised seasonal factors; these may be used to calculate the mean absolute revisions due to seasonal factors; unrevised seasonally-unadjusted data are calculated as:

$$Xr_{sa}(t) = X_{nsa}(t)^{1st} * sf(t)^{3rd}$$

Changes of levels are equal to:

$$(Xr_{sa}(t) / X_{sa}(t)^{1st})-1)*100$$

Previous BEA Publications and Presentations

Brown, Robert L., and James P. Stehle. 1990. "Evaluation of the State Personal Income Estimates." Survey of Current Business 70 (December 1990): 20-29.

Carson, Carol S., and George Jaszi. 1986. "The Use of National Income and Product Accounts for Public Policy: Our Successes and Failures." Bureau of Economic Analysis Staff Paper No. 43. Washington, DC: U.S. Government Printing Office. January 1986.

de Leeuw, Frank. 1987. "The Reliability of GNP." Paper presented at the meetings of the Allied Social Science Associations, Chicago, IL. December 1987.

Donahoe, Gerald F., and Teresa L. Weadock. 1990. "Updated Measures of Revision for Quarterly GNP Estimates." Survey of Current Business 70 (April 1990): 27-28.

Grimm, Bruce T. and Robert P. Parker. 1998. "Reliability of the Quarterly and Annual Estimates of GDP and Gross Domestic Income." Survey of Current Business 78 (December 1998): 12-21.

Jaszi, George. 1965. Pp. 100-187. "The Quarterly National Income and Product Accounts of the United States: 1942-62," in Goldberg, Simon and Phyllis Deane, eds. Income and Wealth: Series XI: Studies in Short-Term National Accounts and Long-Term Economic Growth. International Association for Research in Income and Wealth. London: Bowes & Bowes.

Mankiw, Gregory N., and Matthew D. Shapiro. 1986. "News or Noise: An Analysis of GNP Revisions." Survey of Current Business 66 (May 1986): 20-25.

Parker, Robert P. 1984. "Revisions in the Initial Estimates of Quarterly Gross National Product of the United States, 1968-83." Paper presented at Seminar on Provisional and Revised Estimate of Economic Data, University of Florence, Italy. November 1984.

Parker, Robert P. and Teresa L. Weadock. 1994. "Time Series Revisions: The Effects on Gross Domestic Product." Paper presented at Seminar on New Directions in Statistical Methodology, Council on Professional Associations on Federal Statistics. Bethesda, MD. May 25-26, 1994.

Young, Allan H. 1974. "Reliability of the Quarterly National Income and Product Accounts of the United States." Bureau of Economic Analysis Staff Paper No. 23. Washington, DC: U.S. Government Printing Office. July 1974.

Young, Allan H. 1987. "Evaluation of the GNP Estimates." Survey of Current Business 67 (August 1987): 18-42.

Young, Allan H. 1993. "Reliability and Accuracy of the Quarterly Estimates of GDP." Survey of Current Business 73 (October 1993): 29-43.

Young, Allan H. 1996. "Reliability and Accuracy of Quarterly GDP Estimates: A Review," in John W. Kendrick, ed. The New System of National Accounts. Norwell, MA: Kluwer Academic Publishers: 423-49.

Chart 1

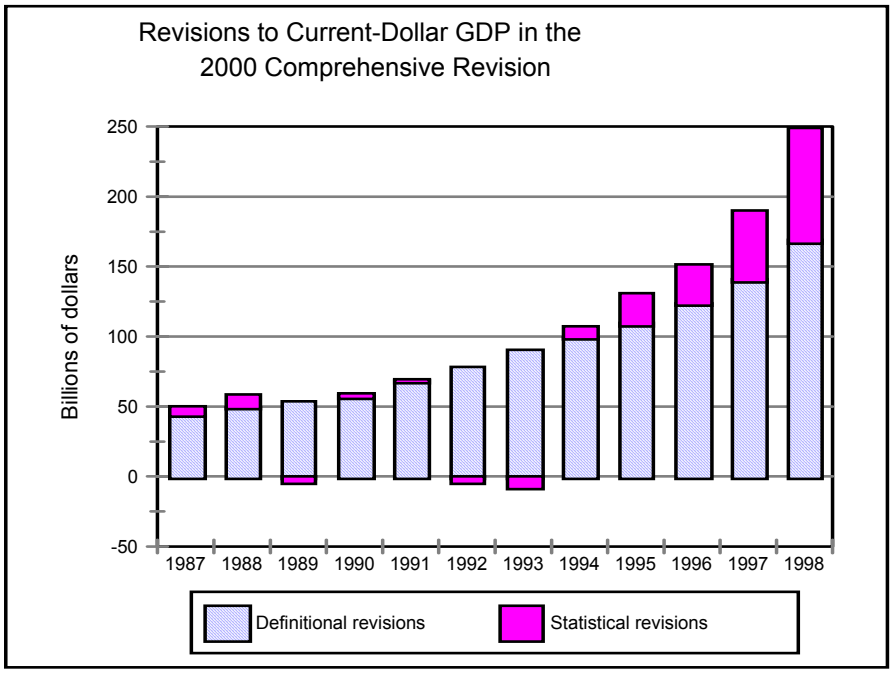

Chart 2

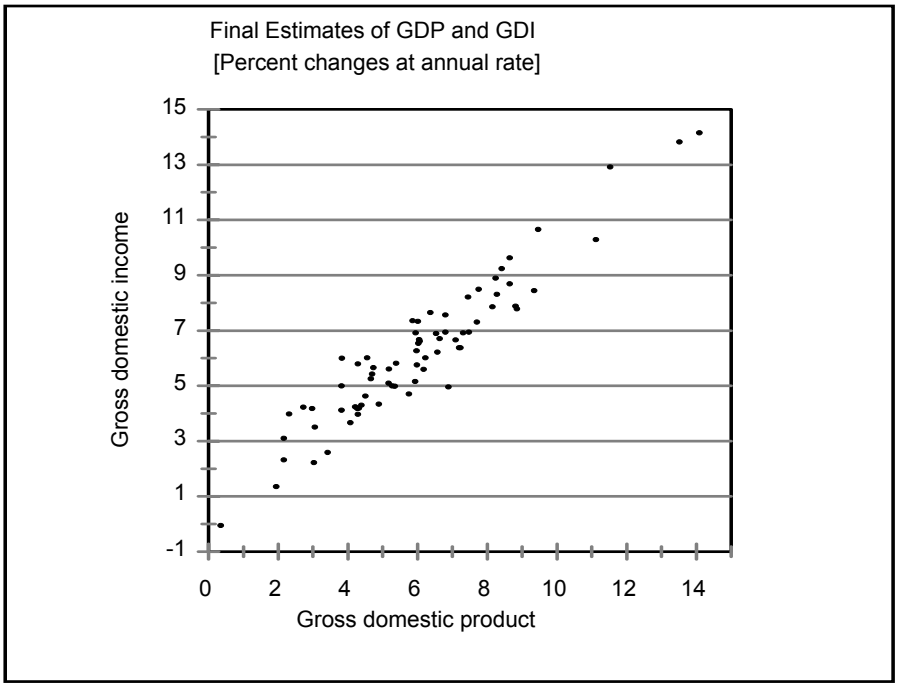

Chart 3, panels 1 and 2